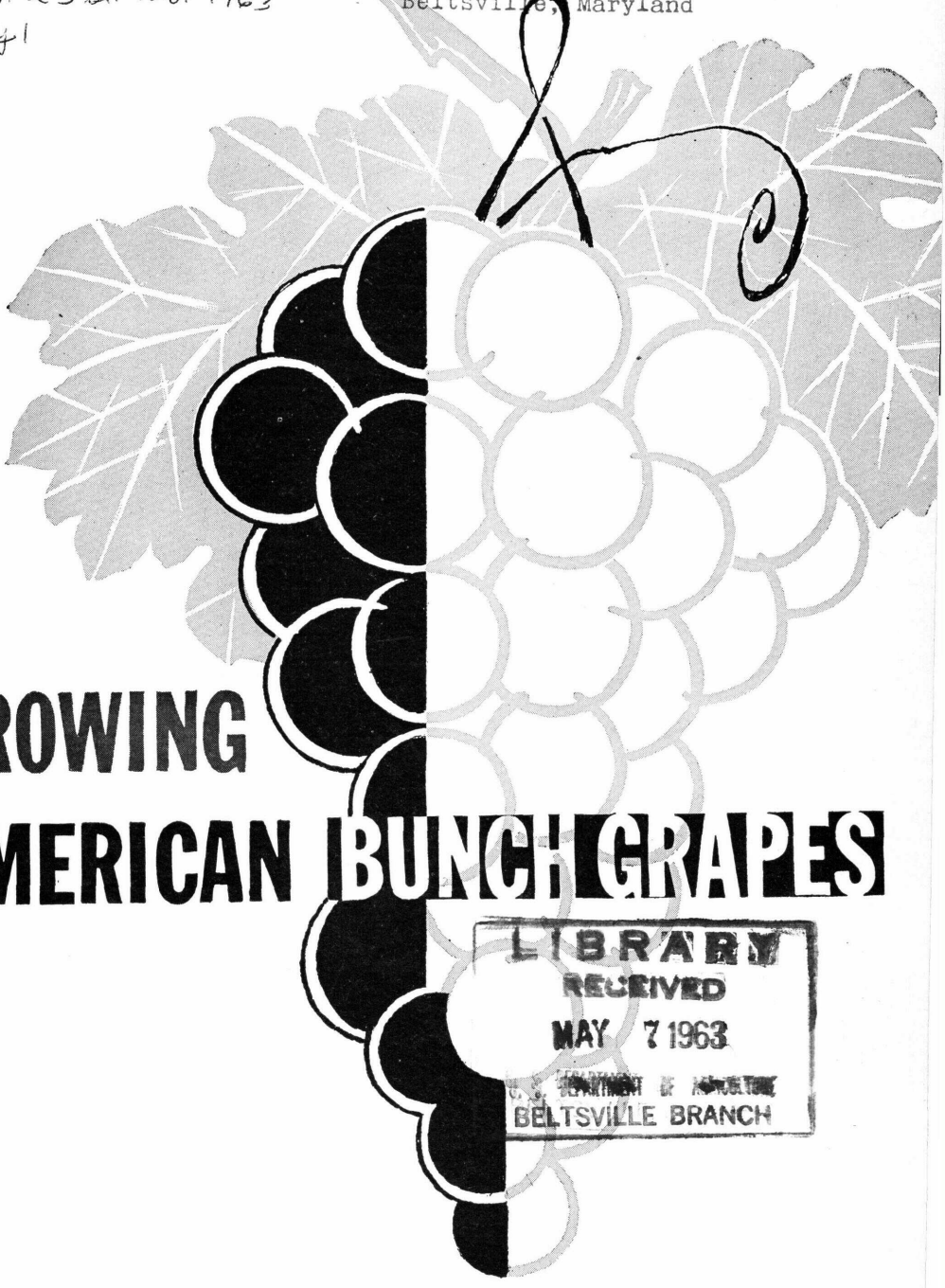

GROWING AMERICAN BUNCH GRAPES

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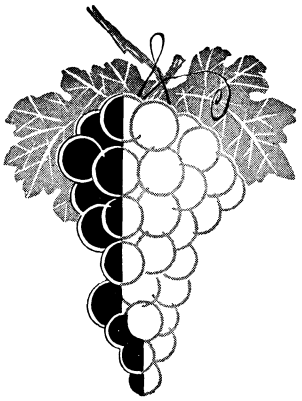

GROWING AMERICAN BUNCH GRAPES

By N. H. Loomis, *Crops Research Division, Agricultural Research Service*

The American-type bunch grape is the only type that is suitable for growing in most parts of the United States. Bunch grapes are one of the most popular and extensively grown fruits in home plantings. They are easy to grow, come into bearing early, bear regularly, and are small but long-lived plants. Usually, insects and diseases are easily controlled on this fruit. American bunch grapes are grown commercially in at least three-fourths of the States.

It is only in (1) arid sections without irrigation, (2) locations with very short growing seasons, (3) locations with extremely severe winter temperatures, or (4) areas having high temperatures and extremely high humidities that growing of bunch grapes is greatly limited or entirely unsatisfactory.

DEVELOPMENT OF THE INDUSTRY

Grapes have always been an important fruit in this country. The first settlers attempted grape culture, using imported varieties; however, these vines were not suitable for most areas. After superior native vines were selected and propagated about 1800, grape culture flourished. By 1825–30, a few hundred acres were in vineyards; by 1955, approximately 125,000 acres were in American bunch grapes.

The production of the commercial crop averages more than 180,000 tons per year, having a value in excess of $18,750,000 (10-year average, 1945–54). More than 80 percent of the crop is used for juice, jellies, jams, or frozen products. Therefore, the varieties for commercial production are determined largely by their suitability for processing.

ORIGIN OF AMERICAN VARIETIES

Most American bunch grape varieties originated from the fox grape (*Vitis labrusca*). This species is native to a comparatively small area in the eastern part of the United States, yet it and its hybrids are grown almost exclusively in all commercial plantings of American bunch grapes in the United States.

The frost grape (*V. riparia*) has produced extremely cold-hardy varieties that mature fruit in a very short growing season. Many are excellent wine varieties. Species of *V. champini*, *V. lincecumi*, *V.*

rupestris, and *V. bourquiniana* produced most of the varieties for the South. Other American species of bunch grapes have contributed few important vineyard varieties.

Bunch grapes intercross readily, and many varieties of today are hybrids of two or more species. The vinifera, European or Old World grape (*V. vinifera*), has been hybridized extensively with American species to develop varieties with superior fruit quality, larger berries, and larger fruit clusters. Unfortunately, the vinifera grape is not so resistant to diseases, phylloxera, and nematodes and it is less cold hardy than the American fox and frost grapes. The weaknesses of the vinifera grape are transmitted in varying degrees to the hybrids.

GRAPE DISTRICTS AND PRINCIPAL VARIETIES

AREAS OF PRODUCTION

Areas of commercial grape production are quite localized, although grapes are adapted to a wide area (fig. 1). The principal areas of commercial production of American bunch grapes are along the eastern and southern shores of Lakes Michigan, Erie, and Ontario; the Finger Lakes section of New York; the lower Hudson River Valley; the south-central section of Washington State; the Ozark section of Arkansas and Missouri; and the Missouri River Valley in Nebraska, Kansas, Iowa, and Missouri. These plantings are almost exclusively of Concord variety. Other varieties planted to some extent are Niagara, Delaware, Catawba, and Campbell Early.

The choice of varieties for commercial use is determined by the demands of the local market and the economics of production. For instance, there is a decided preference for purple grape juice with Concord flavor. Until a market has been established, it would not pay to produce large quantities of yellow, pink, or red juice from other varieties, regardless of quality. Varieties free of "foxy" or "musky" flavors are usually preferred for wine.

Some of the varieties described below are seldom grown commercially, but they are often highly prized by grape fanciers because of very fine dessert quality, unusual flavor, or superior juice or wine properties.

American bunch varieties that are suitable for the regions shown in figure 1 and that are suggested for home planting are as follows:

For region	*Varieties recommended*
1	Beta.
2	Portland, Fredonia, Moore Early, Delaware, Worden, Diamond, Niagara, Concord, Golden Muscat, Sheridan, Catawba.
3	Fredonia, Campbell Early, Delaware, Worden, Diamond, Niagara, Concord, Ellen Scott, Catawba, Lenoir, Norton.
4	Champanel, Extra, Carman, Ellen Scott, Lenoir, Marguerite.
5, 6	Beta.
7	Campbell Early, Delaware, Worden, Diamond, Niagara, Concord, Ellen Scott, Golden Muscat.
8	Campbell Early, Worden, Diamond, Niagara, Concord, Golden Muscat.

VARIETAL DESCRIPTIONS

Beta has an exceptionally vigorous vine and bears a small cluster of small, purple grapes. The vine withstands extremely low winter temperatures, and the fruit ripens in a short growing season so it can be grown considerably north of the Concord area. The fruit is high in

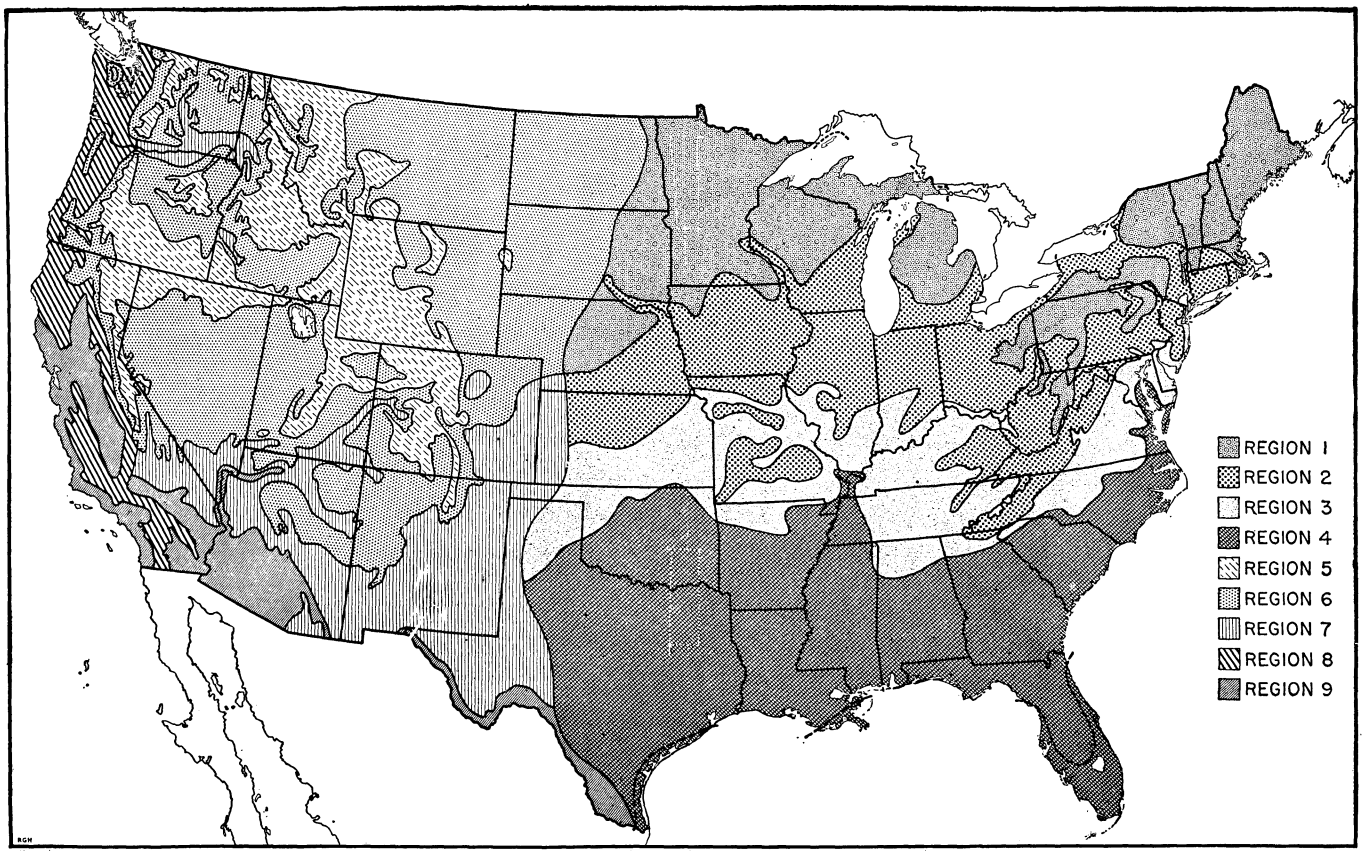

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FIGURE 1.—Regions in United States where specific varietal groups of grapes are adapted.

sugar and acid, and is used primarily for jelly and juice. Beta is usually planted where varieties of higher quality cannot be grown.

CAMPBELL EARLY is grown commercially to some extent in the Pacific Northwest (often under the synonym "Island Belle") and to some extent in the Ozarks. The berries are large and black and are very fine in quality when grown under ideal conditions. It has rather serious weaknesses, however. The vine is only moderately vigorous, and it frequently sets a "stringy" fruit cluster.

CARMAN is a reddish-purple grape of inferior quality, which is grown commercially in northern Texas and Oklahoma. The clusters are tight, and the vines are vigorous and productive. It is grown only where better quality varieties are not well adapted.

CATAWBA is a large, purplish-red grape with a very pleasing and distinctive flavor, known universally as "Catawba flavor." It is used primarily for wine, but also for dessert and juice. The juice is delicious, but different from that of Concord.

The clusters are large. The fruit ripens about 2 weeks later than Concord, so it cannot be grown to the northern limit of the Concord area.

CHAMPANEL is a late, purple grape grown to a limited extent in the South. The vines are excessively vigorous and long lived in an area where most varieties soon fail. The production is fair, but not proportional to the vigor of the vines. The fruit cluster is long and often poorly filled. The berries are large and extremely juicy and have a high acidity and a low sugar content.

CONCORD is the leading variety in practically all of the districts where American bunch grapes are grown commercially. It is well known, hardy, widely adapted, disease resistant, productive, and makes a pleasant, distinctive, and well-colored juice. It is the standard by which both the vine and fruit of other varieties are judged. Its fruit quality, however, is surpassed by many varieties that are less profitable to grow.

The purple fruit is borne in medium- to large-sized tapered clusters. The berries are large and round. They are highly aromatic and have a "foxy" flavor. Both the sugar and acid content are medium. Over 90 percent of the unfermented grape juice from American-type grapes bottled in this country is from Concord, and considerable quantities of distinctively flavored wine are made from this variety.

DELAWARE is a standard of quality wherever it is grown. The fruit is pink, and both the clusters and berries are small. The sugar content is high and the acid content medium. It is highly prized, both for dessert and for champagne.

The vine is rather weak and not so hardy as Concord; it is resistant to diseases, and in relation to its vigor it is productive.

DIAMOND is a medium-sized, yellowish-green grape with medium-sized, compact clusters that are often shouldered. The berries are rather tart, but of good quality. They sometimes crack. The vine is of medium vigor and productive.

ELLEN SCOTT is a large, violet-colored grape produced in very large clusters. The pulp is so tender that the seeds practically float in juice; the quality is excellent. The vine is vigorous but so susceptible to anthracnose that it should be grown in comparatively dry regions. It matures very late.

EXTRA is a large purple grape that is borne in medium-large clusters. The flavor is quite distinctive and typical of the wild post oak (*V. lincecumi*) grapes. This variety is grown throughout the Southeastern States, and at one time was grown commercially in Florida under the name "Florida Beacon."

FREDONIA, under good conditions, is one of the best of the Concord-type grapes. The berries are large, and the clusters medium sized and well filled. Its quality is very good. It ripens 2 to 3 weeks earlier than Concord, but it is not so widely adapted nor so consistently productive.

GOLDEN MUSCAT produces enormous, well-filled clusters of yellow fruit with a distinctive and pleasing muscat flavor. The vines are extremely vigorous and productive. It is a late-season variety that is grown by many home gardeners.

LENOIR is a small, dark grape that produces enormous clusters of superior quality fruit for juice and wine. The vines are vigorous and extremely productive. Unfortunately, Lenoir requires a long season, it is tender to winter cold, and it is so susceptible to diseases (anthracnose and black rot) that it is adapted only to comparatively dry regions.

MARGUERITE is another small-berried purple grape of very fine quality for juice. The clusters are small and the vines are extremely vigorous and productive. It requires a long season. The vine roots with difficulty, so that it is not a favorite with nurserymen.

MOORE EARLY is a purple grape of the Concord type; in fact, it is a Concord seedling that ripens about 2 weeks earlier than Concord. The vine is not so productive nor vigorous, the fruit

is not so good in quality, and it often cracks badly.

NIAGARA, when well grown, is a large grape in large and full clusters. The mature fruit is amber colored with a heavy gray bloom. It is moderately acid with a medium sugar content and a strong "foxy" flavor. In the region where fox grapes are native there is some demand for "foxy" grapes. It is not of high quality, but Niagara sells well because of its size and beauty.

NORTON, like Lenoir, produces small, dark-colored fruit of exceptionally fine quality for juice and wine. Norton is hardy and disease resistant. The variety is vigorous but of comparatively slow growth; it has medium productivity. It is propagated from cuttings, but it is comparatively hard to root.

PORTLAND is an extremely early yellowish-white grape. Both the berries and clusters are large, and the clusters fill well. The quality for eating "out of hand" is generally good, and it is probably the best very early grape for home plantings. It is not adapted to commercial plantings, because the skin is very tender and tears badly in handling.

SHERIDAN is a large, black grape of the Concord type. The fruit is of high quality, very firm, ripens late, and keeps well in storage.

WORDEN, another Concord seedling, is similar to its parent, but with larger berries. The quality is good. The vine is vigorous and productive, and its fruit ripens about 10 days earlier than Concord. Like Moore Early, the fruit sometimes cracks badly.

OTHER VARIETIES.—A number of varieties of very fine quality have been introduced recently, but they have not been tested sufficiently to make recommendations. These include Interlaken and Romulus, both seedless varieties, and Schuyler and Steuben.

DIRECT PRODUCERS

The selections variously known as "Direct Producers," "French Hybrids," and "Franco-American" varieties are hybrids between the European (*Vitis vinifera*) and American grapes. Many are the result of repeated crossings to *V. vinifera*, so that they often have very fine quality and also many of the weaknesses of *V. vinifera*. The "Direct Producers" were developed for phylloxera resistance and can be grown on their own roots where phylloxera is a problem.

A number of these selections have been imported from Europe in recent years and are in demand for trial, especially by amateur grape growers and winemakers. The acreage in these grapes, however, is small. The better known selections are those originated by Seibel, Seyve-Villard, and Couderc; they are usually identified by the names of the originator and the selection number, as Seibel 1000.

CLIMATE

The length of the growing season is a limiting factor in grape production in the Northern States. The major commercial areas are located where there is (1) a frost-free period of 150 to 180 days, (2) a low relative humidity, and (3) where summer rains do not occur often, but where soil moisture does not become critically deficient. Rainfall near the time of maturity adversely affects the quality of the fruit and may cause the fruit of certain varieties to crack, resulting in serious losses. Many grape diseases thrive under humid conditions. In the West and Southwest grape production is often limited by lack of rainfall or water available for irrigation.

VINEYARD SITE

A vineyard needs a well-drained soil and a relatively frost-free site. Level or gently sloping land that is somewhat elevated is best. Sites to the south and east of large lakes are very favorable for vineyards.

Large bodies of water change temperature slowly and have a moderating effect on their surroundings; plant growth is retarded in the spring (often sufficiently to escape late frosts); and frosts on such sites are delayed in the fall.

A northern slope is cold, and it, too, may retard growth enough to avoid damage from late frosts. The crop matures somewhat earlier on a southern or eastern slope. A western slope is exposed to the prevailing winds, which in some areas are strong enough to cause damage. Where the rows run east and west, as on a northern or southern slope, the prevailing winds from the west will dry the dew and rain from the foliage quickly and help to prevent diseases.

At the northern limit of a variety's range, a few days' delay in ripening may cause a crop loss. In such areas the direction of the slope is most important; elsewhere, it is a minor consideration.

Hillside sites are suitable for grapevines, but such land is very subject to erosion.

The commercial vineyards along the Great Lakes and in New York State are mostly confined to rather narrow districts (1) where the temperature is influenced by large bodies of water, (2) where the land is elevated but adjacent to still higher land, and (3) on the deeper and more fertile soils.

SOIL

Grapes will grow in a great many different soils. The fertile, deep, and well-drained loams are best, but soils that contain sand, gravel, shale, slate, or clay can be used. Soils underlain with hardpan are not well adapted, nor are those that are shallow and underlain with gravel or sand. Vine growth is usually improved where there is organic matter.

All grape varieties are not equally adapted to acid or to alkaline soils, but varieties or rootstocks can be selected that are highly tolerant to either of these conditions. Drainage is a primary requirement of grapes; if the land is not well drained, it is not good grape soil regardless of other desirable soil characteristics.

The soil exerts considerable influence on the crop. Excessively rich soils and those with a high organic content produce a heavy but late-maturing crop with a low sugar content. Light soils tend to produce light yields of early-maturing fruit with a high sugar content and a comparatively weak vine growth. The effects of the soils upon the fruit quality are reflected in the quality of the juice and wine.

PROPAGATION

CUTTINGS

Most American bunch grapevines are grown on their own roots. These are normally propagated from cuttings of the previous season's growth, although cuttings that bear a small portion, or heel, of the previous year's growth (fig. 2) root easily. Obtain cuttings from prunings any time during the dormant season. If the cuttings are taken early, however, the wood has less chance of being winter-injured. Select well-matured wood at least one-third inch in diameter.

Make the basal cut just below a bud, although this location is probably not important. For varieties

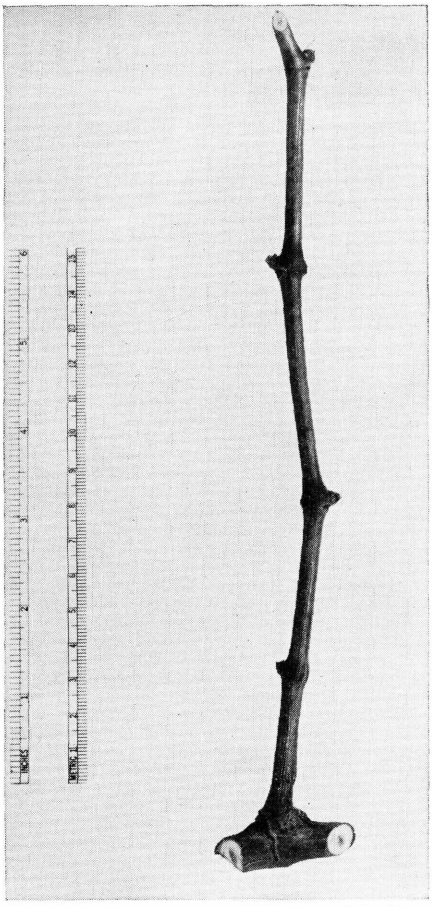

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FIGURE 2.—Heel, or mallet, cutting of grape.

of the Concord type, select canes with joints 3 to 5 inches long and cuttings at least 3 buds long. With weaker growing varieties, such as Delaware, use wood with shorter joints and leave more buds per cutting. To facilitate handling and bundling, make the cuttings of a variety approximately the same length regardless of the number of buds. Where propagation wood is scarce, as for rare or new varieties, one- or two-bud cuttings are sometimes used.

Tie the cuttings in small bundles, with all the buds pointing in the same direction. If bundles are tied with cord, use type of cord that will not rot readily. Store bundles prior to planting in a well-drained trench or cool cellar and cover them with soil, sand, sawdust, or similar material to prevent the cuttings from drying.

Have the soil well prepared in the nursery before planting and keep it well fertilized and free of weeds. Set the cuttings 4 to 6 inches apart in the rows with one bud above ground. Depending on the equipment used in cultivating the nursery, space the rows 2 to 4 feet apart. The usual spacing is 3 to 3½ feet.

In the South, plant cuttings any time from fall to early spring; in colder areas, plant in early spring. Firm the dirt around the cuttings at the time they are set. Where there is alternate freezing and thawing, mulch cuttings set in fall and winter to protect them from heaving. Plant cuttings in the nursery before any growth of roots or shoots occur on them.

ROOTSTOCKS

Rootstocks for grapes are used to prevent or to lessen injury from nematodes and phylloxera and to increase vigor in weak-growing varieties. Adapted and compatible stocks can improve the vigor, lengthen the life of the vines, increase the yields, and reduce uneven ripening of the fruit. In many locations experiments with different types of rootstocks have benefited the grower; yet, the results are so erratic that it is impossible to make general recommendations.

The following rootstock varieties have given good results and are recommended:

For New York—*V. riparia* × *V. rupestris*, Nos. 3306 and 3309; Mourvedre × *V. rupestris*, No. 1202; Clinton; and Riparia Gloire.

For Maryland—*V. riparia* × *V. rupestris*, No. 3309; *V. monticola* × *V. riparia*, No. 8815.

For Missouri—*V. cordifolia* × *V. riparia*, No. 125–1; *V. riparia* × *V. rupestris*, No. 3309; and Constantia.

For Georgia, Mississippi, and Texas—Dog Ridge.

Use rootstocks that are adapted to the location in which they are grown and use stocks that are compatible with the scion varieties that are to be grafted upon them.

GRAFTING AND BUDDING

In grafting, either the whip-and-tongue or the cleft graft is used (figs. 3 and 4). Do the work early, before growth starts and before the flow of sap is heavy, or do it after the first heavy flush of growth is over. Where the vines are worked in the field, make the grafts close to the surface of the ground and mound over with loose earth to prevent drying out. If

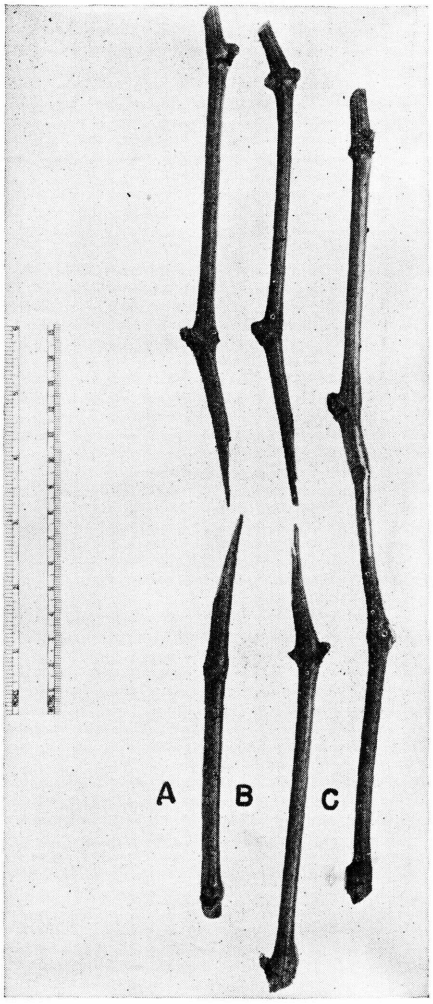

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FIGURE 3.—The whip-and-tongue graft: *A*, Long diagonal cuts on the stock and scion; *B*, faces of stock and scion cut and ready for fitting; *C*, the graft completed and wrapped with polyethylene.

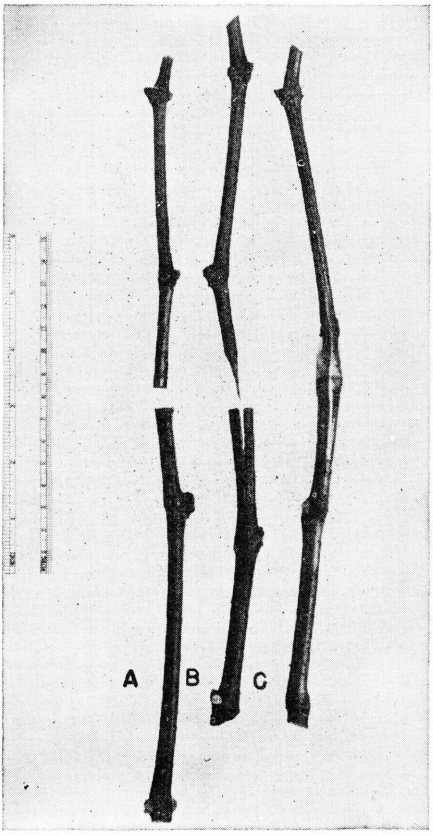

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FIGURE 4.—The cleft graft: *A*, Stock and scion; *B*, stock and scion cut; *C*, the graft fitted and wrapped with polyethylene and fastened with scotch tape.

polyethylene is used to wrap the graft, mounding with earth is not necessary. Use either rooted or unrooted cuttings. Remove the buds on the rootstock to prevent or greatly reduce suckering.

Chip budding is usually done in August (fig. 5). The buds are mounded the same as in other grafts.

To prevent girdling of the stem, remove the string, rubber budding strips, or polyethylene used to secure the grafts after 8 to 10 inches of growth is made by the scion. Loosen the ties of the chip buds about 6 weeks after setting the buds. After the strips or ties are removed, mound the earth again around the union or the bud.

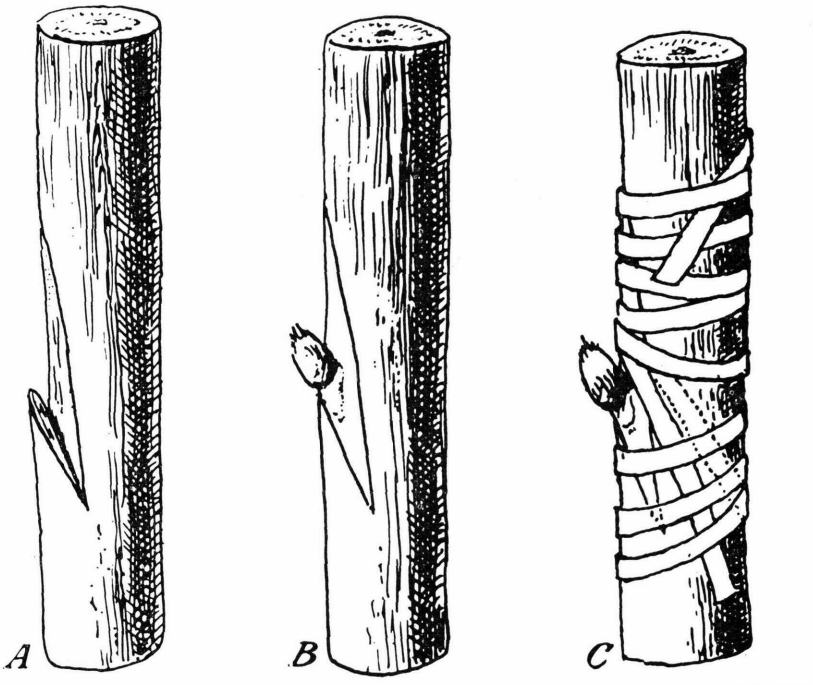

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FIGURE 5.—The bud graft; *A*, Cut made in stock for bud; *B*, bud placed in stock; *C*, bud wrapped in place.

PREPARATION OF THE LAND FOR THE VINEYARD

A vineyard is a planting that lasts a long time; therefore, lay it out so that the soil will not erode, the fertility can be maintained, and the land can be easily tilled. A large vineyard is more easily managed if it is intercrossed by roadways wide enough to turn equipment without always traveling the entire length of long rows. Wide spacing is also needed at the ends of rows.

Plow the land deeply and disk it until the soil is well pulverized before the grapes are planted. If the land has been in sod or has not been cultivated for some time, plant a row crop for at least one season before you prepare the land for the vines.

Straight rows are desirable, but if the available land will erode when planted in straight rows, plant the

vineyard on the contour. Where a contour planting is required, it is well worth all the extra time required to lay it out: (1) It will add many years to the productive life of the planting; (2) it will make the management of the vineyard easier; and (3) it will aid in maintaining the fertility of the soil, which will influence the yields. In contour planting, the line posts may require extra bracing and need to be a little closer together. It is more difficult to keep the wires tight on the contour. It is also necessary to arrange the short or point rows so that undue time or trouble will not be needed to "dead head" equipment back and forth. Roadways in contour plantings need to be carefully placed and constructed to prevent erosion.

Consult your county agent or Soil Conservation Service technician before you lay out the vineyard on the contour. Many States and Federal publications provide additional information on land preparation for contour plantings.

PLANTING DISTANCES

The character, fertility, and depth of the soil, together with the available moisture supply, largely determine the vigor of the vines and the number of each variety that will be required per acre. Set the vines far enough apart in the row so that the canes of adjacent plants will not overlap after pruning. Yields per acre are increased by increasing the number of vines until they begin to compete with each other for space on the trellis and for nutrients and moisture in the soil. Concord, in the areas in which it is better adapted, is usually set 8 to 10 feet apart within the row. Delaware, which is less vigorous, is set 7 to 8 feet, and other varieties are spaced according to their vigor.

Vines in older vineyards in the old grape growing sections around the Great Lakes and in New York State were set very close together. Even today, new vineyards in that area are often planted more closely than in other sections.

Set single-row plantings of vines about as far apart as those in a vineyard; with less competition for plant food and moisture, these vines may be somewhat more vigorous than those in a vineyard planting.

ERECTING THE TRELLIS

The construction of a grape trellis is essentially the same as the construction of a farm fence, but a generous allowance must be made for the weight of the vines and fruit and for the wind resistance offered by the foliage of the vines. Allowance for wind resistance is especially important.

The general recommendation is to set trellis posts within the row twice as far apart as the planting distance recommended for the variety. Usually the vineyard rows are 10 feet apart. This width allows cultural and spray equipment to be moved freely without injuring the vines.

A durable type of wood, such as black locust, Osage-orange, redcedar, white oak, or "fat" pine, is preferred for posts. The usefulness of less desirable types of wood can ordinarily be increased by treating the posts with a good wood preservative, such as creosote or pentachlorophenol. Reinforced concrete or heavy steel posts are expensive, but their "life" is almost unlimited, and

there is not the expense and trouble of replacements. If steel posts are used, they must be heavy enough to resist bending in a strong wind when the grape foliage is thick. Steel posts are adapted only to soils heavy enough to hold the post in line.

An occasional steel post among wood or concrete posts will ground the trellis and may prevent damage to the vines from lightning.

End posts need to be somewhat longer and heavier than line posts and should be well braced. If an end post "gives" or fails, it weakens the entire trellis. End posts are set to a depth of 3 feet and line posts to a depth of 2 feet.

For further information on the selection of posts, and details of construction and bracing, see USDA Farmers' Bulletin 1832, "Farm Fences."

No. 9 wire is ordinarily used for grape trellises, but on a 2-wire trellis, the lower wire is occasionally as light as No. 11. Nos. 9, 10, and 11 wires provide approximately 1,700, 2,050, and 2,600 feet, respectively, per 100 pounds.

If the wire is hung on the windward side of the posts, the staples pull out less readily. Do not drive the staples in completely, but allow the wires to slide under the staples to facilitate tightening. Tighten the wires late in winter or early in the spring before the vines are tied.

PLANTING THE STOCK

When establishing a vineyard, set strong 1-year-old plants. Two-year-old nursery plants may be those that were too small to sell the previous season. In established bearing vineyards on land well suited to grapes, the strong vines tend to remain strong but those vines that are weak remain comparatively weak regardless of what is done to them.

Plant grapevines at about the same depth as they grew in the nursery, or slightly deeper. Prune to a single cane two or three buds long. Do this pruning before the plants are set, as it makes them easier to handle.

Ordinarily, set two vines between wooden posts. Wood preservatives commonly used are generally toxic to plants, so vines should not be set against treated posts. Also, the root systems of vines planted against posts may be seriously injured when posts are replaced. Where steel or concrete posts are used, the grape hoe is easier to use if a vine is set at each post with one vine in between.

Set vines directly under the trellis, as vines that are out of line are constantly injured in cultivation. Injuries weaken the vines, shorten their life, reduce production, and increase the cost of cultivation.

TRAINING AND PRUNING

Training refers to the way in which the growth of the vine is distributed upon a trellis or support, and training determines the shape or form of the vine. Pruning is the removal of parts of the plant. Young vines are trained by some pruning, and mature vines are pruned to maintain a system of training; therefore, training and pruning of grapes are essentially one operation.

After the vines are trained to the desired form, the primary purpose of pruning is the production of marketable fruit. This is done by limiting the number of fruit-producing buds. The number of

buds influences the number and size of the clusters produced, the time of maturity, and also the quality and quantity of fruit. Overproduction depresses growth; vigorous vines are necessary for the development of the current season's crop and for the development of satisfactory wood for the next crop. Judicious pruning can accomplish many things: (1) Sustain yields by providing a balance between fruiting and growth; (2) obtain optimum production in a minimum of space; and (3) improve vineyard management, including harvesting, cultivation, and the control of insects and diseases.

The buds within the middle portion of a grape cane [1] produce more fruit than those at either end, and vigorous medium-sized canes produce more fruit than weak or excessively vigorous canes. The fruit is produced on the current season's growth. Select a system of training and pruning that will utilize as many of the more productive buds as possible. Select the system early in the establishment of the vineyard, so that all training and pruning of the vines will be toward the development of that system.

AMOUNT OF PRUNING

The amount or severity of pruning varies with the vigor of the vine, as more wood and a greater number of buds are left on vigorous vines. A method that serves as a guide to the beginner is to leave between 30 and 40 buds for the first pound of the past season's wood removed in pruning, and 8 more buds for each additional pound of the past season's wood removed. Under irrigation in Washington, where grapevines are more vigorous than they are in the East, 60 buds are left for the first pound of the past year's prunings and 20 buds for each additional pound of pruning.

Even experienced pruners should weigh wood and count buds on an occasional vine to guide them in maintaining a good standard.

Prune weak vines more severely than stong vines. Weak vines produce short jointed wood, so that a very short cane on a weak vine often has more buds than a long cane on a vigorous vine.

Some modification in pruning is necessary to take care of varietal differences in American bunch grapes. For instance, the Beta grape of *V. riparia* origin produced much greater yields in Minnesota when 70 to 90 buds were left than when 40 were left. The fruit clusters of this variety are small, so it is not surprising that Beta responds to less severe pruning than Concord.

TIME OF PRUNING

Where winter temperatures are low enough to injure grape canes, delay pruning until late winter or early spring, when it will be possible to select uninjured canes for fruiting. In some instances, pruning prior to severe freezes increases winter injury of grapes. By delaying pruning until after the severe winter freezes, you can select the hardy, well-matured canes and also avoid the winter injury due to early pruning.

Occasionally only the buds on a cane are injured. Bud injury does not occur often, and then it is usually not detected until growth starts or fails to start the following spring.

In areas of mild winters where grapes are rarely injured, prune them at any time during the dormant season when the temperature is above freezing. Canes are brittle and easily broken if pruned or handled when they are frozen.

Vines pruned very late in the spring will "bleed" freely, but there

[1] Cane refers to the dormant wood of the past season.

is no evidence that this is injurious. Vines pruned just before growth starts or after the buds swell leaf out a little later than vines pruned earlier; this delay may be sufficient to avoid frost injury in some years. However, it is extremely difficult to prune and tie vines after growth starts without destroying many of the buds.

TRAINING SYSTEMS

The Four-Cane Kniffin

The four-cane Kniffin system of training has been the most popular method for the American bunch grapes. It gives good production, is simple to use, and requires no summer tying. The trellis normally consists of 2 wires: The lower is about 30 inches from the ground and the upper 24 to 30 inches higher. The trunk of the vine extends to the top wire. Two canes about 10 buds long are left at each wire on opposite sides of the trunk. Two renewal spurs (canes 2 to 3 buds long) are left on the trunk at each wire, or preferably 6 to 8 inches below (fig. 6). The growth of the renewal spurs is strong early in the spring, and if the spurs are below the wire the growth will be supported by the wire and will not be so readily destroyed by high winds. Each winter the old arms are replaced—usually by canes from the renewal spurs—and new renewal spurs are left, always keeping them close to the trunk.

If possible, train a single cane to the top wire at the end of the first season, and remove all other growth. If there is no cane long enough to reach the top wire, train one to the lower wire; if none reaches either wire, cut back the growth to a single stub two buds long as at planting time. The year after the trunk is established, lay the four canes down along the wires (as explained above) and leave the first renewal spurs.

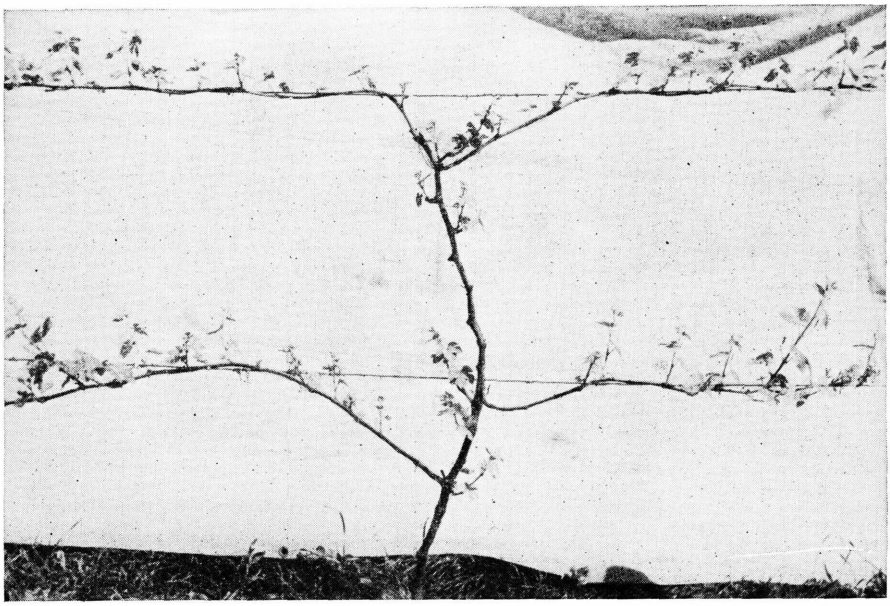

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FIGURE 6.—Young vine trained to the Kniffin system. The renewal spurs are low, to lessen wind damage to the spring growth.

Raising the height of the trellis to 6 feet or more and increasing the space between wires give an increased yield, because the growth is more exposed to light and sun. This height also hastens fruit maturity slightly. Where the growing season is very short, this modification can make the difference between a crop and a failure.

The Umbrella Kniffin

The trellis used for the umbrella Kniffin system is the same as that used for the four-cane Kniffin system. The vines are trained to a single trunk that extends to the upper wire; the 2 to 4 canes and the 2 renewal spurs originate near the top of the trunk. The canes are looped over the top wire, then brought down obliquely to the lower wire, and tied (fig. 7). It is necessary to leave the canes much longer than those in the four-cane Kniffin system in order to have approximately the same number of buds per vine.

Excellent quality fruit is produced under the umbrella Kniffin system. When the vines are vigorous, the yields are frequently as great as those for some other systems of training.

Munson

The Munson system is a modification of Kniffin type. Three wires are used. The upper two wires are approximately 5 feet high and are on the outer edges of cross arms extending out 9 to 12 inches from the posts. The other wire is strung on the posts 6 to 8 inches lower, so the wires are in the shape of a wide **V.** The vine consists of 2 canes and 2 spurs, although the number of canes is increased, according to the vigor of the vine. After pruning, the 2 canes are tied on the lower wire and the new growth droops over the outer wires.

The Munson system is recommended particularly for humid climates, because the fruit is produced high above the ground, where

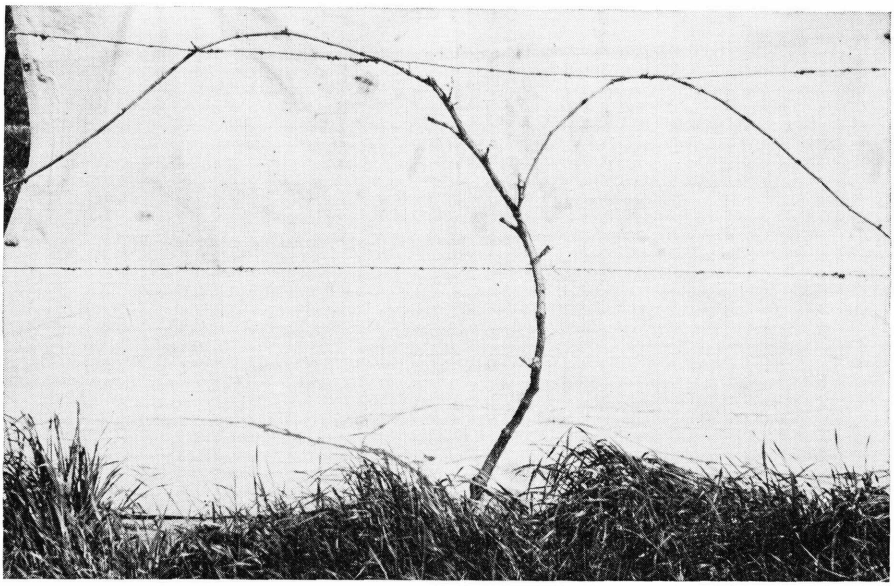

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FIGURE 7.—A young vine trained to the umbrella Kniffin system.

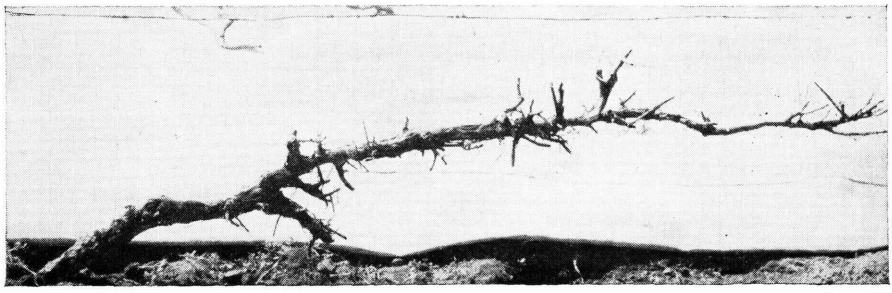

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FIGURE 8.—Vine trained to a modified Chautauqua system. Such vines are easily laid on the ground for protection against winter injury.

it is less injured by diseases. For American bunch grapes it is used primarily in experimental vineyards and very little commercially. However, for the production of vinifera-type grapes, various modifications of this trellis system are used extensively.

Modified Chautauqua

Where it is desirable to cover tender varieties of grapes for winter protection, a trunk may be developed at a narrow angle from the ground to the first wire (fig. 8). The spurs and canes are developed along the trunk, which is tied to the wire. The new canes, or current season growth, are tied to an upper wire. In the fall the trunk is bent to the ground and the vine is covered.

Arbors

Arbors are seldom used commercially, but they are often constructed around homes to give shade and fruit. When the vines are pruned to canes that are well spaced over the trellis, the yields are very good. Oftentimes the vines are pruned to short spurs two to three buds long to provide a quicker and more uniform covering of the arbor.

In a recent test in Missouri of cane-pruned vines that were trained to arbors, the yields of fruit were phenomenal.

RENEWING TRUNKS

Occasionally it is desirable to replace the trunk of a vine. In order to do so, train a strong sprout or sucker from the the base of the old trunk to the trellis as though it were a cane of a young vine. After 2 years the framework should be established. Then, greatly restrict the number of canes from the old trunk to permit the new framework to produce a good crop. The following winter (the third) remove the old trunk completely. This method should result in little or no loss of crop.

TYING

In the four-cane Kniffin and the Munson systems of training, the canes are spiraled around the wires and fastened or they are tied parallel to the wires. If spiraled, wrap the canes firmly from the trunk outward or give one loose turn around the wire. Use extra ties at the base of the canes or at trunk where the canes are looped loosely over the wire once or if they are tied parallel to it. Where the canes are looped or spiraled around the wires, the weight of the crop is partially supported by the wires. Spiraling tightly necessitates careful pruning the next year or the trellis wires will be cut. Where the canes are looped over the wire once or where

they are tied parallel, pruning is not difficult.

Canes of vines pruned to the umbrella Kniffin and Chautauqua systems are pulled across the proper wire and tied.

Tie tightly only the ties at the ends of the canes just back of the end bud; on all other ties, allow room for growth. Since the end tie is tight, leave an extra bud on each cane and rub off the one beyond the tie.

Complete the tying before the buds start to swell, as the buds are easily rubbed or knocked off.

Material for ties should be sufficiently durable to last and retain strength for several months and should make a knot that will not slip. Binder twine is most commonly used, but many other materials are suitable.

TREATMENT OF FROST-INJURED VINES

Occasionally late frosts severely injure the new growth of grapes. When this happens remove all new growth. The buds of grapes are compound, and when the first growth is removed a secondary bud normally develops and produces a partial crop. A larger crop is obtained if the injury occurs when the primary growth is very short. Practically no crop is produced from buds that develop from uninjured parts of the new growth, so such injured new growth should be removed.

A few shoots on frosted vines may be uninjured. Where the injured shoots only are removed, the uninjured ones that are left make enormous growth. Very few secondary buds will develop from partially stripped vines, for complete stripping is necessary to force secondary growth. Partial stripping results in ill-shaped vines that are difficult to prune satisfactorily the following winter. Usually vines frosted sufficiently to warrant stripping should be stripped completely, but the extent of the injury in each case should determine the treatment.

When the growth is long and only the tips and terminal leaves appear to be injured by frost, the flower clusters may open in an apparently normal manner, then shed without setting much fruit. Under these conditions it is impossible to determine the exact degree of injury right after the frost. Therefore, if injury appears mild, it is safer not to strip. Such vines will produce a partial crop without stripping, and stripped vines never produce more than a partial crop.

CULTIVATION

Grapes respond to cultivation, and vineyards are normally cultivated at least during the spring and early part of the summer. To avoid serious injury to the roots, do not plow or disk more than 3 or 4 inches deep. A bottom plow of 2 to 4 gangs, depending upon the space between the grape rows, is excellent for the first cultivation. The plow covers the trash and can be operated at very shallow depth. A tandem disk is also good. A disk harrow throws dirt to the vines and causes difficulty in keeping the planting level. A spring-tooth harrow, set shallow, is excellent to keep down weeds if it is used occasionally after the initial spring cultivation.

Within the grape row, the grape hoe is excellent if used by an experienced operator. Dirt is plowed to the vines in one cultivation and away from them in the next. The grape hoe gets practically all the weeds and reduces to a minimum the

amount of hand hoeing. Grape hoes may be attached to the tractor and operated by the driver or they may be separate tractor or horse-drawn units.

The power rotary hoe can also be used under the trellis. The revolving head works between the vines but retracts and goes around any object, such as the trunk of a grapevine or a post. The object trips a sensitive automative trigger on the cultivator head. This trip mechanism is operated manually among plants too small or too limber to work the trigger.

On hillside vineyards that are subject to erosion, follow a system of trashy cultivation. Keep a litter on the ground and keep the land rough enough to pocket and hold water to prevent erosion. Cultivate often enough to prevent weeds from competing seriously with vines but infrequent enough to keep some growth and trash on the land. A tandem disk is excellent, as it can be adjusted to loosen the soil without turning it.

Make every effort to keep grapevines in a vigorous condition; weak vines set poor "stringy" fruit clusters and are unproductive. Lack of vigor is a real problem in most vineyards. Cultivation and the use of nitrogenous fertilizers stimulate weak vines.

Excessively vigorous vines also set fruit poorly, even though they blossom freely. Restricting growth at the time the vines are blossoming can increase the set of fruit. A fast-growing cover crop, such as oats or rye, which competes strongly with the vines for plant nutrients and moisture, often restricts excessive growth of the vines. Normal cultivation is resumed after the fruit is set. Lack of cultivation, reducing the applications of nitrogenous fertilizer, or leaving more fruiting wood helps to curb excessive vigor of vines.

Under some conditions it is desirable to restrict growth in the fall so that the canes will mature properly to withstand winter temperatures. Also, restricting the growth of vigorous vines a few weeks before the fruit ripens often improves the quality of the crop. To restrict growth, sow the vineyard to a fast-growing cover crop during the summer.

To aid in the control of the grape berry moth, which overwinters in the soil, the following cultural methods are helpful. Throw up a low, wide, and almost level ridge of soil under the trellis with a grape hoe, plow, or disk. Do this a month to a month and a half before harvest. The grape berry moth larvae form their cocoons on pieces of leaves under the trellis, and these will accumulate on the ridge of soil. In the spring and at least 2 weeks before the average date of grape bloom, pull the ridge into the row middle with the grape hoe. Disk the middles so as to cover the cocoons with a compact layer of soil at least 1 inch deep. This will prevent the moths from emerging. Another method is to ridge the rows 2 weeks before bloom in the spring to cover the cocoons. With both methods, leave the covering undisturbed until 2 weeks after bloom.

CHEMICAL WEED CONTROL [2]

It is difficult to remove weeds from under the trellis with a grape hoe without some damage to the vines. A spray solution of DNBP [4,6-dinitro ortho secondary butylphenol], commonly known as a dinitro contact weed killer, fortified

[2] This section was prepared by L. L. Danielson and W. C. Shaw, Crops Research Division.

with diesel fuel oil is a good herbicide for use in the vineyard. The most common spray formula is 2 pounds of DNBP (2 pints of any available formulation containing approximately 50 percent DNBP), 10 gallons of No. 2 diesel fuel oil, and 90 gallons of water. Spray the mixture at the rate of 100 gallons to the acre of actual area sprayed on a strip 2 to 3 feet wide under the trellis. This rate of application to a strip 2 feet wide in rows 8 feet apart would require 25 gallons of spray solution per acre of vineyard. If heavy growth of weeds is present, apply the spray at the rate of 150 gallons per acre of actual area sprayed.

Most satisfactory weed control is obtained when 3 spray applications per season are used. Apply the first spray when the weeds are 4 to 6 inches high. Apply succeeding sprays at 3- to 4-week intervals when weeds have again attained a height of 4 to 6 inches. Since the DNBP, oil, and water form an unstable emulsion, agitate the emulsion continuously in the sprayer while it is being applied. Use a sprayer that employs a gear pump capable of maintaining a pressure of 35 to 40 pounds per square inch.

The DNBP spray mixture will damage any succulent grape growth such as leaves or young canes that hang down from the trellis or come in contact with the spray. Do not use this herbicide in a young vineyard that is just being established.

In areas in which temperatures exceed 90° F. for extended periods, vapors from DNBP may cause minor contact injury and marginal leaf discoloration. Where such high temperatures prevail and past experience indicates that vapor injury may occur, it may be desirable to reduce the amount of DNBP in the spray and add a residual type pre-emergence herbicide. In order to avoid vapor injury and to extend the period of weed control it is suggested that a DNBP–CIPC [isopropyl N–(3-chlorophenyl) carbamate] spray be applied as the second treatment prior to the emergence of the weeds following the first application. Mix 1 pound oil-soluble DNBP and 6 pounds CIPC in 20 gallons of oil plus 80 gallons of water and apply the oil-water emulsion at the rate of 100 gallons per acre.

Some herbicides such as 2,4–D [2,4-dichlorophenoxyacetic acid], sesone [sodium 2,4-dichlorophenoxyethyl sulfate], and TCA [trichloroacetic acid] are very injurious to grapes. Do not use these herbicides in or near vineyards for any purpose.

Do not use spray equipment to apply herbicides for weed control in grapes that has been used to apply 2,4–D and related herbicides for weed control in other crops, unless the equipment has been thoroughly cleaned and it is known to be free of these herbicides.

Caution.—Some herbicides may be injurious to man and animals. Handle herbicides with care. Follow all directions and heed all precautions on the container label.

COVER CROPS

Where land is cultivated intensively, cover crops are necessary to maintain the organic matter content of the soil, which helps to maintain yields of the vines. The small grains, and particularly rye and oats, are well adapted for a winter cover crop in a vineyard, as they make good growth quickly. Ryegrass is sometimes used. These grass crops, however, do not add nitrogen to the soil. If possible, include legumes as a cover crop in areas where they are adapted.

Vetch is widely adapted. In the Southern States crimson clover, burclover, and blue lupine may be used.

Crops seeded with a drill are less difficult to clean out of the grape rows in the spring than those that are broadcast. Seeding rates vary with the location.

In some locations summer cover crops, such as soybeans, buckwheat, millet, and cowpeas, are used as an additional source of organic matter.

FERTILIZERS

Fertilizers are used in vineyards to supplement the plant foods that are deficient or unavailable in the soil. Thus, fertilizer needs will vary with the kind of soil.

In eastern United States applications of nitrogen and potash frequently increase yields. In the Pacific Northwest some growers use nitrogen. In the Southeastern States growers generally apply complete fertilizers containing nitrogen, phosphorus, and potassium. In the Middle West, vineyards will benefit little from the use of fertilizers.

Boron, zinc, and magnesium are helpful in a few areas, primarily on poor sandy soils in the coastal States of the East and South. Phosphorus in most areas benefits grapes little, but this fertilizer generally aids the growth of cover crops sufficently to warrant its use in vineyards.

Appreciable quantities of essential plant foods are supplied by the addition of organic materials—barnyard manure, straw, hay, and grape pomace. Materials such as sawdust and straw, if not well rotted when applied, require additional applications of nitrogen.

Lime seldom benefits grapes. However, in highly acid soils lime helps or is necessary for the growth of legumes when they are grown as vineyard cover crops. On soils deficient in potash, applications of lime or of nitrogen may increase the deficiency symptoms for potash.

WINTER PROTECTION

Varieties that are not completely winter-hardy can often be grown considerably beyond their range. In the fall the trunks and canes are bent to the ground and covered over with soil, cornstalks, or similar material. To do this, these varieties should be trained to a modified Chautauqua system.

In the more arid sections drying winds during the winter when the vines and ground are frozen often cause damage as severe as that from extremely low temperatures. A windbreak of trees, cornstalks, or comparable material is often sufficient protection, but covering the plants affords greater protection.

HARVESTING AND FRUIT MATURITY

Many grape varieties change color long before they are fully ripe, and practically all varieties become both sweeter and less acid as they mature. For this reason, color is a poor index of maturity. Taste or the color of the seeds, which change from green to brown, usually determine maturity of table grapes. Soluble solids, obtained by the use of a refractometer or Balling hydrometer, and the sugar content suitable for the use intended determine the harvest date for juice

and wines. The content of soluble solids does not increase after clusters are removed from the vine.

Even though the quality of the fruit may be highest by harvesting only fully ripened clusters, it is sometimes necessary to harvest the crop before the fruit is fully mature. There is always danger of loss when fruit matures on the vines. Some varieties tend to crack after maturity, and rain increases this tendency. On susceptible varieties ripe fruit rots spread rapidly during rainy weather. Where the growing season is short, a freeze or frost may damage the crop. In some locations birds do an enormous amount of damage, and mature fruit cannot be left on the vines unprotected without serious loss. In a home planting clusters on a few vines can be protected by bagging with kraft bags or by covering the vines with netting.

YIELDS

Yields from good commercial vineyards in the East and Midwest are generally about 3 tons per acre. Yields from vineyards where vines are weak or not well managed average 2 tons per acre.

The commercial irrigated vineyards of Washington State average 4 to 5 tons per acre, which is the greatest production of the American bunch grape in the United States. Some of the best vineyards in that area yield 8 to 10 tons per acre.

Climate and local conditions and various cultural and management practices influence production, so that the yields within one grape-growing area vary greatly.

INSECT AND DISEASE CONTROL [3]

Many American bunch grapes, especially in home plantings, are never sprayed or dusted to control diseases and insects. However, control measures are generally required for maximum production of clean fruit.

The number of spray applications depends upon the location and rainfall. In the northern districts three applications are usually required; in the extreme south, six to eight. Fungus diseases, excepting powdery mildew, cause little difficulty in arid regions. Dust with sulfur to control mildew. Usually no other fungicide is needed to control diseases in such regions.

Insects are apt to be troublesome, however, and spraying with insecticides is necessary. The basic spray schedule for grapes in areas where the grape berry moth is a problem, given in table 1, may be useful to home gardeners. Commercial growers should consult their county agent or State experiment station for spray schedules and the latest information on disease and insect control.

Quantities of spray materials needed to control insects and fungi are given in table 2. *All spray materials are toxic; handle with care. Observe carefully all precautions given on the labels.*

[3] For a description of insects and diseases affecting grapes in the East and for more detailed directions for control, see USDA Farmers' Bulletin 1893, "Control of Grape Diseases and Insects in Eastern United States." This bulletin is available in most libraries.

TABLE 1.—*General spray program for the control of eastern grape insects and diseases*

Application No.	Time of application	Materials (quantities per 100 gal. of water)	Disease or insect	Remarks
1	When new shoots are 7 to 10 inches long.	Ferbam (2 pounds) or bordeaux mixture (6:6:100).	Black rot	Where black rot is serious, apply an extra ferbam spray when the young shoots are 1 to 2 inches long. Add DDT if leafhoppers or flea beetles are serious. If dead arm is present, use bordeaux mixture and not ferbam.
2	3 to 5 days before bloom	Same as above plus DDT 50 percent wettable powder (2 pounds).	Black rot Berry moth Rose chafer Japanese beetle	If mildew or anthracnose is a problem, use bordeaux mixture and not ferbam.
3	Immediately after bloom	Bordeaux mixture (6:6:100 or 4:4:100) plus DDT 50 percent wettable powder (1½ pounds).	Black rot Berry moth Leafhoppers Leaf roller Japanese beetle Mildew	If red-banded leaf roller is present use lead arsenate 3 pounds per 100 gallons of water instead of DDT.
4	At 2- to 4-week intervals after No. 3, as needed, for control of insects and diseases, but not within 45 days of harvest.	Same as 3 above	Same as 3 above	If ripe fruit rots are a problem, use bordeaux alone, or use a fixed or insoluble copper compound as directed on the container 2 to 3 weeks before maturity. The fixed coppers will not discolor the fruit.

TABLE 2.—*Quantities of spray materials for varying amounts of spray and notes on the materials*

Materials [1]	Gallons of spray [2]				Notes
	1	5	10	100	
Bordeaux 6:6:100:					
Copper sulfate	2 T	½ cup	1 cup	6 pounds	General fungicide for the control of grape diseases.
Hydrated lime	6 T	1¼ cups	2½ cups	6 pounds	
Bordeaux 4:4:100:					
Copper sulfate	4 t	⅓ cup	⅔ cup	4 pounds	Bordeaux depresses growth, but it is one of the best general fungicides.
Hydrated lime	4 T	¾ cup	1½ cups	1½ pounds	
DDT [3]—50-percent wettable	1¼ T	½ cup	1 cup	2 pounds	General insecticide for chewing insects.
DDT [3]—75-percent wettable	1 T	5 T	¾ cup	1½ pounds	
Ferbam	2 T	⅔ cup	1⅓ cups	2 pounds	Fungicide—particularly good for the control of black rot—and of slight or no value against most other grape diseases.
Lead arsenate	3 T	⅔ cup	1¼ cups	3 pounds	General insecticide—superior to DDT for control of the red-banded leaf roller.

[1] Bordeaux and ferbam are not compatible. They should not be mixed, and 2 weeks time should elapse between ferbam and Bordeaux sprays to the same vines.

[2] T=level tablespoonful; t=level teaspoonful.

[3] DDT should not be applied within 45 days of harvest.

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